BENCHMARKS FOR DEVELOPING ECOLOGICAL SOIL SCREENING LEVELS (ECO-SSL): EFFECTS OF SELENIUM ON SOIL INVERTEBRATES

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ABSTRACT

Army concepts for the Objective Force include the need to be responsive and deployable. Both of these rely upon proper testing and training. Neither testing nor training can occur without environmental compliance with NEPA, that routinely calls for Environmental Assessments including Human Health Risk Assessment and Ecological Risk Assessment. The U.S. Environmental Protection Agency in a collaborative effort of a multi-stakeholder workgroup including Army, Navy, and Air Force, has established national guidance and SOPs for deriving Ecological Soil Screening Levels (Eco-SSL) for ecological receptors. Unfortunately data in the published literature were insufficient in quantity and quality to establish an Eco-SSL for selenium, critical in various DoD advanced technologies, and frequently found in the environment at testing and training areas. The EC_{20} ecotoxicological benchmarks based on toxicity of selenium to reproduction by the common soil invertebrates earthworm *Eisenia fetida*, potworm *Enchytraeus crypticus*, and collembolan *Folsomia candida*, were remarkably similar yielding the values 3.4, 4.4, and 4.7 mg kg^{-1}, respectively. Selenium benchmarks will be submitted to the Eco-SSL National Task Group for use in developing a selenium Eco-SSL for soil invertebrates. Establishing Eco-SSL leads to increased Army/DoD readiness by supporting environmental documentation required for testing and training.

1. INTRODUCTION

The United States Army has delineated concepts for the Objective Force, and among these are the need to be responsive and deployable. Both responsiveness and deployability rely upon proper testing and training. Neither testing nor training can occur without environmental compliance with the National Environmental Policy Act (NEPA). The Army complies with NEPA requirements as directed in 32 CFR 651 / 65 FR 54348. NEPA routinely calls for Environmental Assessments (EA), including Human Health Risk Assessment and Ecological Risk Assessment (ERA). The U.S. Environmental Protection Agency (USEPA) in a collaborative effort of a multi-stakeholder workgroup consisting of USEPA, DoD (Army, Navy, and Air Force), Department of Energy, states, universities, and consulting and industry representatives, has established national guidance and SOPs (USEPA, 2003) for deriving Ecological Soil Screening Levels (Eco-SSL) for ecological receptors including soil invertebrates. Eco-SSLs are screening ecotoxicity values that can be used routinely to identify contaminants of potential concern in soils that warrant additional evaluation in Baseline ERA, and to eliminate those that do not.

Unfortunately data in the published literature were insufficient in quantity and quality to establish Eco-SSL for all of the most common contaminants of ecological and military importance. The metal selenium is a critical element in various Department of Defense (DoD) advanced technologies, and is frequently found in the environment at DoD testing and training areas. These investigations were undertaken to establish ecotoxicological benchmarks that meet Eco-SSL criteria for deriving screening levels based on the toxicity of selenium to soil invertebrates.

2. EXPERIMENTAL RESULTS AND DISCUSSION

We determined EC_{20} ecotoxicological benchmarks based on reproduction (juveniles produced) for the toxicity of selenium to the soil invertebrates earthworm *Eisenia fetida*, potworm *Enchytraeus crypticus*, and collembolan *Folsomia candida*. Sassafras sandy loam [Fine-loamy,

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siliceous, mesic Typic Hapludult] at pH 7.1, with sand:silt:clay ratio 70:13:17, and 1% organic mater, was utilized in the bioassays. Selenium was added as sodium selenate, and weathered/aged in soil via alternating wetting/drying cycles for 13 weeks. Soil from each treatment level was collected, lyophilized, and stored at –40°C at the initiation and conclusion of each test. Soils were analyzed for selenium by LC/ICP-MS, following nitric:perchloric digestion. Nonlinear regression models were used to correlate ecotoxicity data with selenium concentrations, retained primarily as SeO_4 in this aerobic soil. The benchmarks for selenium were remarkably similar, yielding EC_{20} values 3.4, 4.4, and 4.7 mg kg^{-1} for earthworm, potworm, and collembola, respectively. Selenium benchmarks will be submitted to the Eco-SSL National Task Group for use in developing an Eco-SSL for soil invertebrates; experimental design and results undergo quality assurance before inclusion of benchmarks in the national Eco-SSL database.

3. CONCLUSIONS

Eco-SSL eliminate the need for repetitious costly toxicity-data literature searches; increase consistency; and allow resources to be focused on issues critical to sustaining key testing and training sites. Establishing Eco-SSL leads to increased Army/DoD efficiency and readiness by supporting environmental documentation required for testing and training, essential for force responsiveness and deployability.

REFERENCE

USEPA, 2003: Ecological Soil Screening Level Guidance. U.S. Environmental Protection Agency, http://www.epa.gov/ecotox/ ecossl/, Washington, DC.